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RENEWABLE ENERGIES AND ECONOMIC DEVELOPMENT: EVIDENCES OF STUDY IN PANEL

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ABSTRACT

Purpose - This article sought to investigate possible relationships between the development of renewable energies and some economic and financial indicators of a selected group of countries. The knowledge of these relationships becomes important to understand the process of growth and development of renewable energies around the world.

Design/methodology/approach - The article discusses the possibilities represented by renewable energies; presents hypotheses of possible relationships between the development of some renewable energies sources and economic and financial indicators of a group of countries; allows greater understanding of the economic and financial process associated with the recent development of renewable energies.

Findings - With data collected of the generation of sources of renewable energy and economic and financial indicators of various countries, it was possible to generalize that the growth of renewable energy was related to more developed countries; it was also possible to establish relationships between some types of renewable energy and the economic and financial indicators of the countries.

Research limitations/implications - The number of countries in the sample and the time frame investigated limited the current research.

Practical implications - The knowledge of the business environment in which the development of renewable energy occurred enables the construction of the concept that modern technologies are associated with governments with better management of its finances.

Originality/value - The research is innovative because it creates knowledge integrating two dimensions of science. One dimension is the energy economics and the other is related to the economic and financial aspects of the governments of the countries, which are the largest investment agents such technologies. Results make possible to understand the real need for good economic management of countries, besides allowing understand the global panel of development for each type of renewable energy.

Keywords: renewable energies, sustainability, economic development, linear regression.

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1. INTRODUCTION

There is an increase of the consensus on the need for control measures of the impacts generated by current production processes and patterns of consumption on the environment. Since Kyoto Protocol (1997) the countries and their respective societies seek to determine which measures should be taken to protect the environment from negative impacts promoted by the contemporary process of economic growth.

Kojo *et* Wolde-Rufael (2010) have studied the causal relationship between carbon dioxide (CO2) emissions, renewable and nuclear energy consumption, and USA GDP for the period 1960-2007. It has been observed causality of nuclear energy consumption to CO_2 emissions. It has not been identified causal relationship from renewable energy use to CO_2 emissions. Econometric evidence suggested that nuclear energy consumption helps to reduce CO_2 emissions. However, the renewable energy consumption has not reached a level that can significantly contribute to emissions reduction.

Mathiesen *et al.* (2011) concluded that applying efficiency to energy consumption, to the use of more efficient renewable energies and to conversion technologies might have positive socio-economic effects, generate employment and, potentially, lead to grater gains in exports. Use of 100% renewable energy Systems will be technically possible in the feature, and might even be economically advantageous in comparison with the energy system economically viable in current days.

Based on OECD/IEA (2007) report, Martinelli *et* Midttun (2010) observed that competition among OECD member states and developing countries has imposed a heavy ecological burden over the system we live in, and that it was the development of emerging countries like China and India that has promoted disturbances with worldwide effects in the environment.

In regard to the development of renewable energies as a factor that would help to decrease impacts of the current development model on the environment, Bursztyn (1993) supports that to Northern countries, more developed than Southern ones, and to Eastern countries, fall the burden of bearing more financial resources and technological adjustment in the control of environmental impacts in the field of generation and use of energy.

Lameira *et al*. (2012) point that countries in a further stage of development must be the countries that have promoted the greatest growth of renewable energies generation. Authors understand that countries with higher economic growth rates have economic conditions that allow them to take over the leadership in the development process of such energy sources. Likewise, they have observed that some parameters related to the capacity of gross capital formation and the consumption on the part of citizens, could be associated with the growth of renewable energies generation.

In this sense, it has been identified an absence of studies investigating possible associations between renewable energies generation, and economic and financial performance indicators of the countries. Thus, the present investigation promotes the study of possible associations between indicators of these variables in order to promote the discussion on possible associations between financial and economic components of the countries and renewable energies development.

It has been applied the method of multiple linear regressions on data of renewable energies generation, and economic and financial performance of some sample countries. A panel in the period from 2005 to 2008 was elaborated in order to investigate such relationship.

This paper is organized in 5 sections. Section One contains the subject introduction, in Section Two is developed the literary review on proposed subjects. Section Three presents the methodology used in the study. Section Four addresses the outcomes and Section Five includes the conclusions and final comments, besides suggestions for future researches.

2. BIBLIOGRAPHICAL REVIEW

The development of industrialized and emerging countries, according to OECD/IEA (2007) report has given rise to an intense economic growth in last decades, culminating in an increase of CO_2 emissions, worsening global warming. Since the most important component of this development was the large-scale production, with low costs, after China and other emerging countries enter the world scene, this process was fed with intensive use of energy.

Studying the relationship between development and the environment, Kolstad *et* Krautkaemer (1993) argue that, while the use of resources, especially the energy ones, generates quick gains for economy, the negative impact might take too long to be observed in the environment. In addition, the impacts produced can cause irreversible damages to the ecosystem. Thus, there is a dynamic link among the environment, the use of natural resources and the economic activity.

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Using the environmental, macroeconomic and financial variables, along with indicators of the Kyoto Protocol, Tamazian *et al*. (2009) applied the methodology of linear regression analysis to data on a panel and examined a possible relationship between energy consumption, economic growth and environmental degradation. The authors advocate the hypothesis of the level of environmental degradation decreases as the countries develop, because of the attraction of foreign investments and development of researches and new technologies associated with renewable energies, for example.

The mentioned authors also found a change in the GDP composition of the country members of BRIC (Brazil, Russia, India and China), which during the last twenty years has been decreasing the participation of agriculture and increasing the participation of industry in GDP formation. It causes the investments in these countries to rise, as well as the energy consumption, unveiling a relationship among economic growth led by industrialization, energy consumption rise and environment degradation. In their studies they evidenced that the economic growth variable exerts a positive correlation with energy consumption. This correlation was observed in BRIC countries, more intensively in Brazil, India and China, but Russia percentage was also statistically significant. However, the mentioned investigation does not associate development, whether of BRICs, whether of a larger group of countries, with renewable energies generation.

Studying the purchasing power and the environmental degradation, Grossman *et* Krueger (1992) stated there to be a relationship between the indices of pollution and income, intermediated by mediating variables that promote the association between environmental degradation and economic growth. Nevertheless, a good deal of the levels of environmental degradation and pollution depends on the energy mix they adopt. As regards the means used to generate energy and the energy mix featured by the country, Brien *et al*. (2007) observed that the State participation is essential to determine it.

Percebois (2007), by other side, points a listing of factors that influence in the vulnerability of energy generation and relates several economic and financial factors to this indicator. At last, Hannesson (2009) concluded that a positive relation can be established between the growth of energy use and the economic growth. In this context, it seems like energy consumption is closely related to economic development, as Tamazian *et al.* (2009) remark.

Renewable energy sources represent a powerful alternative to fossil energy resources, especially those derived from petroleum, besides enabling the mitigation of impacts on the environment, which is one of the paradigms of contemporary societies. The renewable energy, abundant and absolutely non-polluting, cheap, clean and permanently renewable, features multiple alternatives, as remarks Alves Filho (2003), but it must go through a path of technological evolution to become tangible. Climate changes, resource shortage and environmental pollution are the reasons for preoccupation when it comes to energy. One of the solutions for the problems derived from this inevitable rise of energy consumption is the investment in new technologies of energy generation, which is clean, safe and inexhaustible, accomplishing thus the risks minimization and enabling economic growth to continue without the environment destruction. In this aspect, the renewable energies have given proof of being efficient and promising as Ottinger *et* Williams (2002) remark.

The diversity of renewable energies, especially in developing countries, has been demonstrating to be an alternative to electrical grids of energy generation, promoting reduction of the losses with transmission and distribution of electric power and, in addition, even playing a role in social inclusion. In this sense, Ottinger *et* Williams (2002) highlight that many rural locations of the world, not supplied with electric power, could benefit from such renewable sources. The authors point out that the most favorable measure, in this purpose, would be withdraw the subsidies associated with the oil and gas industry. However, Heal (2010) found in his studies that the major problem of renewable energies is the intermittent generation, and without the development of proper storage technologies, only the nuclear power, the efficient energy use and the carbon capture are appropriate mechanisms to face the climate changes and the environmental degradation. In alignment with this reasoning, Carson (2012) claims that besides the intermittence and the impossibility of estimating the exact production of a renewable source, the use of soil for biofuels also affects the food production, the high cost of Aeolian technology makes such projects financially impracticable. Some aspects related to the development of renewable energies influence the projects' profitability. Vergura *et* Lameira (2011) remarked that special conditions of energy sale, in this case solar energy in Italy, can change significantly the investment performance. This aspect evidences the importance of incentives and subsidies actions. However, the existence of a policy related to renewable energies is of essential importance so that a set of investments are possible and the cannibalization of renewable energy companies and projects is avoided. In this sense, Fischer *et* Preonas (2013) highlight that elaborating a policy for the development of generation of several renewable energies is an important synergy source, and aggregates value to the overall renewable energy developed in each country.

Table 1 shows the distribution of the world consumption per source for the years of 1973 and 2010.

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Table 1. Final world energy consumption

Year	1973	2010
Energy Sources	**%**	**%**
Oil	48.1%	41.2%
Electric Power	9.4%	17.7%
Natural Gas	14.0%	15.2%
Renewable Energies	13.2%	12.7%
Mineral Coal	13.7%	9.8%
Others	1.6%	3.4%

Source: Key World Energy Statistics – IEA – 2012

The electric power consumption corresponds to 17.7% of the overall world energy consumption. This energy is generated by several primary sources, as shown in table 2.

Table 2. Primary sources of electric power generation in 2010

Energy Sources	%
Mineral Coal	40.6%
Natural Gas	22.2%
Hydroelectric Power	16.0%
Nuclear Power	12.9%
Oil	4.6%
Energies Geothermal, Solar, Aeolian, Biofuels and Thermal	3.7%
Total in 2010	21.431 TWh

Source: Key World Energy Statistics – IEA – 2012

In order to investigate the possible association between renewable generations and economic development, some indicators were selected to be measurement of what we understand as economic development. It was assumed that the gross fixed capital formation (GFCF), the domestic product growth (GDPG) and the *per capita* income (GDPPC) were indicators that denote an economy's capacity of wealth generation as Hannesson (2009) remark.

The gross fixed capital formation is the index that indicates how much the companies have increased its capital assets, i.e., those with duration of over a year, enabling the production of other assets and ensuring that the country's production base will have the means to raise its production capacity in the following years, causing no inflation, demonstrating that entrepreneurs are confident in the country's development and growth, and therefore will continue to invest as Lameira *et al*. (2011) observe.

As remarks Perroux (1961) apud Kon (1991), all economic progress is linked to the capital assets accumulation and its efficient employment, which raise the human work return and the real productivity of the society. Therefore, it is understood that the gross capital formation (GFCF) is an efficient indicator of the current and future development capacity of the economy and of the effort toward the expansion of its production potential.

On the other hand, the Gross Domestic Product Growth (GDPG) points the wealth generation capacity of a country in a period of time. Generally, the countries' products are measured every year, so to accomplish comparability in this indicator. However, in the individual's perspective, *per capita* income (GDPPC) indicates the individual's capacity to access goods and services and, thus, being actors promoting the sustainable growth of the economy in question.

Thus, in this paper it sought to study the relationship between the growth of renewable energies generation and the economic development. So it is assumed that such variables are aligned, as point Lameira *et al*. (2012).

3. METHODOLOGY

It was promoted a secondary data collection, by means of telematics, at the sites of World Bank, Social Science Research Network (SSRN), World Economic Forum (WEFORUM) and Energy International Agency (EIA), in order to build the indicators of this study's empirical investigation. The investigation period stretched from 2005 to 2008 and gathered a set of 54 countries that have available data in the sample investigated.

The method of linear regressions was applied for investigation of the possible statistic relationships between the indicators of renewable energies generation and others mentioned before, and the indicators representing the levels of countries economic growth. The study's objective is to find possible statistically significant relationships among such variables. The methodology of models for the data in panel combines characteristics of time series with cross-section data, and is widely applied to econometric studies.

Hsiao (1986) says that the panel models feature a series of advantages over the models of cross-section or the ones of time series, since those models control the heterogeneity present in the others. Another advantage, according to Hsiao (1986), is that the panel data enable the use of more observations, increasing the degrees of freedom and decreasing the collinearity among the explaining variables. Other advantage of the panel data is that they are capable of identifying and measuring effects that cannot be detected by means of cross-section data or time series separately.

To investigate such possible relationship, it was used some indicators related to renewable energies generation and measured in Joule x 10^6 and indicators of economic development like GDP, in billions of dollars, *per capita* GDP and the gross capital formation.

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The dependent variables of the study are the indicators of renewable energies such as: a) aeolian energy generation; b) biodiesel production; c) ethanol production; d) biofuels production; e) energy generation from the energies solar, tidal and of waves; f) energy generation from biomass and waste; g) geothermal energy generation; h) generation of hydroelectricity.

3.1. Hypotheses

Aiming at coming to a conclusion about the possible association between renewable energies generation and economic development, the following hypothesis were tested:

H1: it is believed that higher generations of alternative energy are associated with countries presenting higher growths of GDP. Apergis and Danuletiu (2014) used data from 80 countries and tested the relationship between use of renewable energy and economic growth. They havefound significant statistical results for the long-run relationship between these two variables. Positive relationship (+);

H2: it is believed that higher generations of alternative energy are associated with countries owning higher investments in infrastructures (GFCF). Lameira *et al*. (2012) showed that countries in a new stage of development, ie countries which have higher levels of investment, among other indicators, should be the countries that promoted the further growth of renewable energy generation. Positive relationship (+);

H3: it is believed that higher generations of alternative energy are associated with countries whose *per capita* GDP is higher. Arifin *et* Shahruddin (2011) founded Granger causality running from renewable energy consumption to GDP per capita in Indonesia. Positive relationship (+);

The expectation is that countries featuring larger infrastructures and more potential to grow need more energy sources, and this increases the chances of enabling a higher renewable energy production within the mix of new energy sources. In addition, a higher *per capita* GDP ensures the payment for the consumption of this energy to be generated, what usually, for being new technologies, are more expensive than those fossil energies and other polluting sources.

3.2. Models

The variables arising in the equations have already suffered transformations provided that the distribution of these variable values need to meet the parameters of a normal distribution as in Hair *et al*. (2005).

In the statistic tests carried out in the study, the equations have isolated each variable, relating then to the indicators of economic and financial development of diverse countries. For each one of the dependent variables, transformations were tested to find distribution as close as possible of a normal distribution, i.e., it has been used the transformation generating the best as in Hair *et al*. (2005). Thus, the dependent variables have suffered the following final transformations. Then, the letter "L" before the variables related below means that the variable was transformed by applying the logarithmic function, the letter "S" indicates that the variable suffered transformation by applying the square root function and the letter "I" means that the inverse function was applied.

The models of study for each of the renewable energies are exposed as follows:

$$\text{Leolian (Aeolian energy)} = c(1) + c(2) \times GFCF + c(3) \times LGDPG + c(4) \times SGDPPC + \xi \quad (1)$$

$$\text{Igeothermal (Geothermal energy)} = c(1) + c(2) \times GFCF + c(3) \times LGDPG + c(4) \times SGDPPC + \xi \quad (2)$$

$$\text{Lhydroelectric (Hydroelectric energy)} = c(1) + c(2) \times GFCF + c(3) \times LGDPG + c(4) \times SGDPPC + \xi \quad (3)$$

$$\text{Ibiofuels (Energy from biofuels)} = c(1) + c(2) \times GFCF + c(3) \times LGDPG + c(4) \times SGDPPC + \xi \quad (4)$$

$$\text{Ibiodiesel (Energy from biodiesel)} = c(1) + c(2) \times GFCF + c(3) \times LGDPG + c(4) \times SGDPPC + \xi \quad (5)$$

$$\text{Ibiomasswaste (Energy from biomass and waste)} = c(1) + c(2) \times GFCF + c(3) \times LGDPG + c(4) \times SGDPPC + \xi \quad (6)$$

$$\text{Iethanol (Ethanol)} = c(1) + c(2) \times GFCF + c(3) \times LGDPG + c(4) \times SGDPPC + \xi \quad (7)$$

$$\text{Isolartidwaves (Energies solar, tidal and of waves)} = c(1) + c(2) \times GFCF + c(3) \times LGDPG + c(4) \times SGDPPC + \xi \quad (8)$$

$$\text{Soverenener (Overall renewable energies)} = c(1) + c(2) \times GFCF + c(3) \times LGDPG + c(4) \times SGDPPC + \xi \quad (9)$$

Where,

c(1): constant of the regression equations:

c(2): constant associated with the variable Gross Fixed Capital Formation (GFCF);

c(3): constant associated with the variable GDP Growth;

c(4): constant associated with the variable *Per capita* GDP.

ξ: error term of the equations

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4. OUTCOMES AND CONCLUSIONS

In Table 3, it is shown the outcomes generated from the equations 1 to 9. Tests were performed for each renewable energy groups. Evidence points towards a positive relationship in the three relationships studied, as pointed out by the positive relationship between the Soverenener indicator and the GFCF, LDPG and SGDPPC indicators. However, only the relation between Soverenener indicator and the GFCF indicator showed statistical significance.

Only the results for the relationship between the hydroelectric and geothermal energy and economic indicators confirmed the hypotheses tested. The results for the other energies were sometimes contradictory for one hypothesis.

Table 3. Tests outcomes

	Soverenen-er	Lhydroe-lectric	Leolian	Isolartid-waves	Igeother-mal	Iethanol	Ibiomass-waste	Ibiodiesel	Ibiofuels
C	1.4852 (07899)	1.4299 (0.0792)	0.3487 (0.3829)	0.7800 (0.0000)	0.3611 (0.2530)	0.6505 (0.0973)	-0.6132 (0.0843)	-0.1878 (0.6111)	-0.2746 (0,5100)
GFCF	0.1529* (0.0149)	0.0149 (0.1022)	0.0173*** (0.0001)	-0.0020 (0.2423)	-0.0041 (0.2410)	-0.0134** (0.0025)	-0.0040 (0.3158)	-0.0063 (0.1272)	-0.0116* (0.0133)
LGDPG	0.0261 (0.9953)	-0.3472 (0.5932)	-0.6931* (0.0312)	0.2532* (0.0368)	0.5655* (0.0261)	0.3555 (0.2568)	1.3064*** (0.0000)	1.0084*** (0.0008)	1.0388** (0.0021)
SGDPPC	0.0054 (0.4400)	-0.0015 (0.1303)	0.0025*** (0.0000)	-0.0006** (0.0018)	-0.0003 (0.4666)	-0.0001 (0.9051)	-0.0020*** (0.0000)	-0.0011* (0.0203)	-0.0005 (0.3436)
n	193	193	193	193	193	193	193	193	193
R^2	0.0340	0.0272	0.2322	0.1181	0.0454	0.0498	0.2865	0.1375	0.0924
R^2 adj	0.0186	0.0118	0.2201	0.1041	0.0303	0.0347	0.2751	0.1238	0.0780
D-W	1.6753	1.6518	1.8705	1.9047	2.1310	1.7725	1.4403	1.8102	1.7143

The symbols ***, ** and * represent, respectively, statistical significances of 0.1%, 1% and 10%.

Table 4 presents a synthetic summary of the outcomes grouped for each of the variables regarding renewable energy generation. Results for the GFCF and SGDPPCC indicators were ambiguous. Results point in order to confirm the relationship between the indicator GDPG and most renewables energies except the Aeolian energy.

Table 4. Grouped tests outcomes with significance

	GFCF	LGDPG	SGDPPCC
Soverenener	+*	+	+
Lhydroelectric	+	-	-
Leolian	+ ***	-*	+ ***
Isolartidwaves	-	+ *	-**
Igeothermical	-	+ *	-
Iethanol	-**	+	-
Ibiomasswaste	-	+ ***	-***
Ibiodiesel	-	+ ***	-*
Ibiofuels	-*	+ **	-
Total	4 with significance	6 with significance	4 with significance

The symbols ***, ** and * represent, respectively, statistical significances of 0.1%, 1% and 10%.

With regard to outcomes consistency, it is possible to observe that the adjustment of the models, measured by values of R^2 and R^2 adjusted were good and compatible to an exploratory research as in Hair *et al*. (2005). The outcomes of Durbin Watson test, regard to the information content existing in residuals demonstrated these residuals did not contain relevant information to explain the dependent variable and were also good as Hair *et al*. (2005).

Basically, the outcomes showed evidences that the rise of renewable energies use is related to lower GDP growths. This outcome is aligned with the expectation that the most developed countries become pioneers in the development of new energies. Such countries feature higher GDPs and lower growth rates. Thus, to have the renewable energies associated with lower GDP growths was expected.

By another side, the higher use of renewable energies is associated with the higher GDP *per capita.* It is GDPs *per capita* that grants to the population higher purchase power, and is this increase in demand that propels first the consumption, and then the investment. So higher GDPs *per capita* are associated with higher investments in machinery, equipment and infrastructures for production of consumption goods, i.e., it rises the investments in the gross capital formation, which represents the investments done to

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enlarge the capacity of consumption goods production such as cloths, household appliances, etc.

Analyzing individually the outcomes related to each type of renewable energy, it is observed that in the case of hydroelectric energy, there is no significant relationship between the variable Lhydroelectric and the performance of the economic growth indicators as in Hair *et al*. (2005).

As regards the energies: a) aeolian, b) solar, c) tidal and of waves, d) geothermal, e) ethanol, f) biomass and wastes, g) biodiesel and h) biofuels, it was found that the generation growth of this forms of energy are positively related with larger infrastructures (GFCF), inversely related with GDP growth and positively associated with higher *per capita* GDP.

Likewise, the overall renewable energies are positively related to higher infrastructures (GFCF), higher *per capita* GDP and GDP growth.

The outcome of the test with the overall renewable energies verifies the hypothesis that the most developed countries have left the rest of them behind in the renewable energies development as a generation form of non-polluting energy and as a long term strategy to change the energy generator Matrices.

In the same way, the higher use of renewable energies is associated with the higher gross capital formation on the part of countries. Such association provides evidences that the countries featuring larger infrastructures are already investing in higher renewable energies production, aiming at conforming the composition of their energy matrices to a feature that bears enormous possibilities of energy.

It can be concluded yet that the higher the investments in infrastructure, necessary in the emerging countries, the higher will be the demand for energy to the formation of this infrastructure, and then to its use. This is why in developing countries the chances of GDP growth are higher than in developed countries. By other side, countries with higher *per capita* GDP have citizens with higher purchasing power and, therefore, can afford more to have cleaner energies.

For new researches, the suggestion is the inclusion of other factors that might be investigated as explicative factors of the renewable energies generation as: a) the property of larger reservoirs of fossil fuels, b) the existence of local industry with intensive production processes in energy, and c) the countries in different stages of development, among others.

REFERENCES

Alves Filho, J. (2003), "Matriz Energética Brasileira: da Crise à Grande Esperança". Rio de Janeiro: Mauad, 188 p.

Amaeshi, K. and Amao, O. (2009), "Corporate social responsibility in transnational spaces: exploring influences of varieties of capitalism on expressions of corporate codes of conduct in Nigeria", Journal of Business Ethics, v. 86, n. 2, p. 225-239.

Anmandale, D. and Taplin, R. (2003), "The determinants of mining company response to environmental approvals regulation: a report of Australian research", Journal of Environmental Planning and Management, v. 46, n. 6, p. 887-909.

Apergis N., Danuletiu D. C. (2014), "Renewable Energy and Economic Growth: Evidence from the Sign of Panel Long-Run Causality", International Journal of Energy Economics and Policy, v. 4, n. 4, 2014, p. 578-587.

Arifin, J., Shahruddin, N. (2011). "Causality relationship between renewable and non-renewable energy consumption and GDP in Indonesia". Economics and Finance in Indonesia, v. 59, n. 11, p. 1-18.

Brazilian Ministry of Mines and Energy (2012), "Brazilian Energy Balance 2012 / year 2011", available at: <http://www.mme.gov.br/mme/menu/todas_publicacoes.html>. Acessed 20 February 2013.

Mathiesen, B. V., Lund, H. and Karlsson, K. (2011), "100% Renewable energy systems, climate mitigation and economic growth", Applied Energy, v. 88, n. 2, p. 488-501, available at: <http://www.sciencedirect.com/science/article/pii/S0306261910000644>. Acessed 20 August 2013.

Brose, I., Stappen, F. Van and Castiaux, A. (2010), "Articulation of environmental and socio-economic externalities from bioenergy", Management of Environmental Quality: An International Journal, v. 21, n. 6, p. 812-829.

Brunnschweiler, C. N. (2009), "Finance for Renewable Energy: An Empirical Analysis of Developing and Transition Economies", available at: <http://ssrn.com/abstract=1462207>. Acessed 10 February 2013.

Bursztyn, M. (organizer) (1993), "Para Pensar o Desenvolvimento Sustentável". São Paulo: Editora Brasiliense, 161 p.

Campbell, B. (2008), "Regulation & legitimacy in the mining industry in Africa: where does Canada stand?", Review of African Political Economy, v. 35, n. 117, p. 367-385.

Carson, B. (2012). The economics of renewable energy, available at: <http://ssrn.com/abstract=2014773>. Acessed 10 February 2013.

European Parliament and of the Council (2009), "Directive 2009/28/EC of the European Parliament and of the Council on the promotion of the use of energy from renewable sources amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC", Oficila Journal of European

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DOI: 10.14488/BJOPM.2016.v13.n2.a7

Union, L. 140, p. 16-41, available at: <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=Oj:L:2009:140:0016:0062:en:PDF>. Acessed 10 February 2013.

Evuleocha, S. (2005), "Managing indigenous relations: corporate social responsibility in a new age of activism", Corporate Communications, v. 10, n. 4, p. 328-340.

Fischer C. and Preonas, L. (2010), "Combining Policies for Renewable Energy. Is the Whole Less than the Sum of Its Parts?", available at: <http://ssrn.com/abstract=1569634>. Acessed 10 February 2013.

Gifford, B., Kestler, A. and Anand, S. (2010), "Building local legitimacy into corporate social responsibility: gold mining firms in developing nations", Journal of World Business, v. 45, n. 3, p. 304-311.

Grossman, G., Krueger, A. (1992), "Environmental impacts of a North American Free Trade Agreement". National Bureau of Economic Research, Working Paper n. 3914.

Hair, J.; Tatham, R.; Anderson, R.; Black, W. (2005), "Análise Multivariada de dados", 5th edition, Porto Alegre – Bookman, 593 p.

Hannesson, R. (2009), "Energy and GDP growth". International Journal of Energy Sector Management, v. 3, n. 2, p. 157-170.

Hamann, R. (2004), "Corporate social responsibility, partnerships, and institutional change: the case of mining companies in South Africa", Natural Resources Forum, v. 28, n. 4, p. 278-290.

Heal, G. (2010), "Reflections--The Economics of Renewable Energy in the United States", Review of Environmental Economics and Policy, Oxford University Press for Association of Environmental and Resource Economists, v. 4, n. 1, p. 139-154, winter.

Hsiao, C. (1986), "Analysis of Panel Data", Econometric Society monographs, n. 11, New York: Cambridge University Press.

Ihlen, Ø. (2008), "Mapping the environment for corporate social responsibility: stakeholders, publics and the public sphere", Corporate Communications, v. 13, n. 2, p. 135-146.

International Energy Agency (IEA) (2012), "Key World Energy Statistics", available at: <http://www.iea.org/publications/freepublications/publication/name,31287,en.html>. Acessed 10 February 2013.

Kojo, M. and Wolde-Rufael, Y. (2010), "CO_2 emissions, nuclear energy, renewable energy and economic growth in the US", Energy Policy, v. 38, n. 6, p. 2911-2915, available at: <http://www.sciencedirect.com/science/article/pii/S0301421510000303>. Acessed 20 August 2013.

Kolstad, C. and Krautkaemer, J. A. (1993), "Natural Resource Use and the Environment", IN: A.V. Kneese and J.L. Sweeney, eds., Handbook of Natural Resource and Energy Economics, v. III, Elsevier, Amsterdam.

Kon, A. (1991), "A Formação bruta de capital fixo do Estado de São Paulo". Departamento de Economia da FGV-SP, dezembro, available at: <http://www.seade.gov.br/produtos/spp/v05n04/v05n04_15.pdf>. Acessed 10 August 2013.

Lameira, V. J., Ness, W. L., Harris J., Quelhas, O. L. G. and Pereira, R. G. (2011), "The relationship amongst countries' governance, energy and sustainable development". Journal of Modern Accounting and Auditing, USA David Publishing Company, march, v. 7, n. 3.

Lameira, V. J., Harris J. E., Quelhas, O. L. G. and Pereira R. G. (2012), "A study of the relationships among three variables: Character of governance, sustainable growth and energy management", Management of Environmental Quality: An International Journal, v. 23, n. 1 p. 68-81.

Martinelli, A. and Midttun A. (2010), "Globalization and governance for sustainability", Corporate Governance, v. 10, n. 1, p. 6-17, Emerald Group Publishing Limited.

O'brien, G., O'keefe, P. and Rose, J. (2007), "Energy, poverty and governance", International Journal of Environmental Studies, v. 64, n. 5, p. 605-616.

OECD/IEA (2007), World Economic Outlook, OECD/IEA, Paris, available at: <www.oecd.org/>. Accessed 10 September 2009.

Ottinger, R. And Williams, R. (2002), "Renewable Energy Sources for Development. Environmental Law", v. 32, n. 2, available at: <http://ssrn.com/abstract=1299904>. Accessed 10 February 2013.

Percebois, J. (2007), "Energy vulnerability and its management". International Journal of Energy Sector Management, v. 1, n. 1, p. 51-62.

Rajagopal, D. and Zilberman D. (2007), "Review of Environmental, Economic and Policy Aspects of Biofuels", The World Bank Development Research Group Sustainable Rural and Urban Development Team, september. Available at: < http://econ.worldbank.org/external/default/main?pagePK=64165259&theSitePK=469372&piPK=64165421&menuPK=64166093&entityID=000158349_20070904162607>. Accessed 10 February 2013.

Tamazian, A., Chousa, J.P. and Vadlamannati, K.C. (2009), "Does higer economic and financial development lead to environmental degradation: evidence from BRIC countries". Energy Policy, v.37, p. 246-253.

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Volume 13, Número 2, 2016, pp. 208-216
DOI: 10.14488/BJOPM.2016.v13.n2.a7

Vergura, S. And Lameira, V. (2011). "Technical-Financial Comparison between a PV Plant and a CSP Plant". Revista Eletrônica Sistemas & Gestão, v. 6, n. 2, p. 210-220.

Walsh, P. R. (2012), "Prioritizing sustainability strategies for global extractive sector firms", Management of Environmental Quality: An International Journal, v. 23, n. 6, p. 615-629.

WBGU - German Advisory Council on Global Change (2009), "Future bioenergy and sustainable land use", German Advisory Council on Global Change report, available at: <www.wbgu.de/wbgu_jg2008_kurz_engl.pdf>. Accessed 10 September 2013.